

RESTRICTED

**HANDBOOK OF INSTRUCTIONS
WITH
PARTS CATALOG**

REVERSE-CURRENT RELAYS
(FOR AIRCRAFT)

**Model No. 3GTR72A1
Model No. 3GTR72A1A**

Released by
**BUREAU OF AERONAUTICS
U.S. NAVY DEPARTMENT
WASHINGTON, D. C.**

GENERAL  ELECTRIC
**SCHENECTADY, N. Y.
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MEMORANDUM FOR THE DIRECTOR

DATE

1954

RESEARCH AND DEVELOPMENT

1. SUMMARY

2. INTRODUCTION

3. OBJECTIVES

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Fig. 1. Reverse-current relay, Model No. 3GTR72A1, with cover

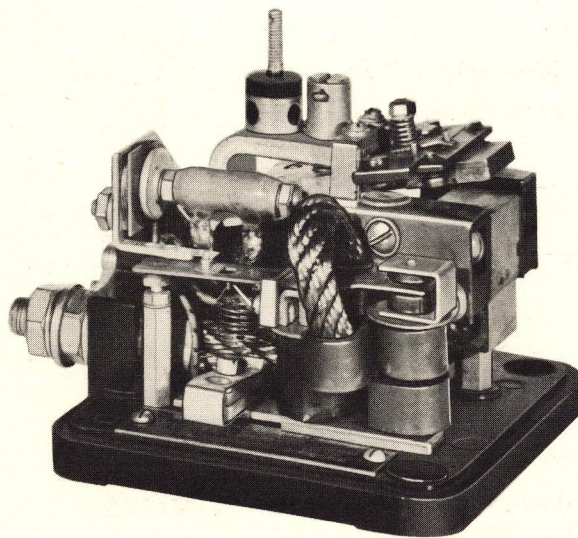


Fig. 2. Reverse-current relay, Model No. 3GTR72A1, cover removed

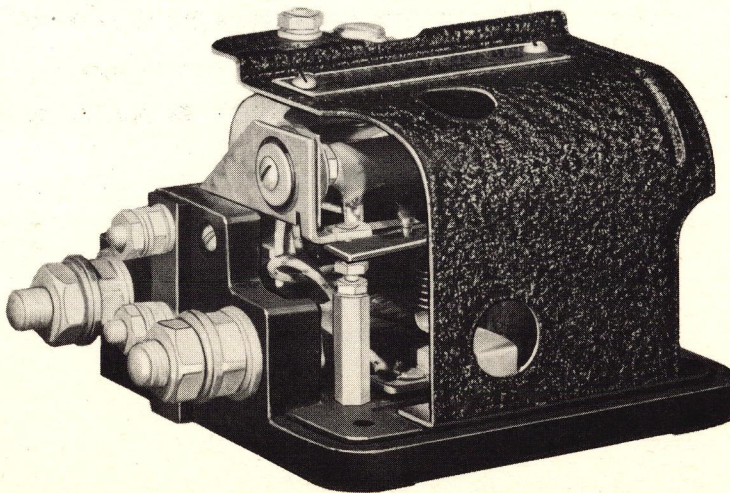


Fig. 3. Reverse-current relay, Model No. 3GTR72A1A

REVERSE-CURRENT RELAYS

MODEL NO. 3GTR72A1

MODEL NO. 3GTR72A1A

INTRODUCTION

The Model No. 3GTR72A1 and 3GTR72A1A Reverse-current Relays, shown in Fig. 1, 2, and 3, are for use on aircraft and operate to connect the generator to the line and to disconnect it from the line at the proper time. The relays can be used with any 30-volt direct-current aircraft generator whose rating does not exceed 200 amperes, regardless of the type of voltage regulator used. Note, however, that the lower the ampere rating of the generator, the higher the reverse-current dropout will be (in proportion to the generator rating).

Listed below are G-E generators and voltage regulators with which the relays have been used in Navy installations. This does not mean, however, that these are the only possible combinations, since the relays may be used with other generators and regulators of the ratings mentioned above.

Generator Model No. Voltage Regulator Model No.

2CM41A4		{	3GBD1A11
		{	3GBD1A11A
		{	3GBD1B18
2CM46A2	}	{	3GBD1A11
2CM70B2		{	3GBD1A11A
		{	3GBD1B18
		{	3GBD1A18
2CM52A1			3GBD2B6
2CM54A1			3GBD2B5
2CM70B4			3GBD1A18
2CM56A1			3GBD1A11
2CM89D1 (d-c end)			3GBD1A18

DESCRIPTION

The Model No. 3GTR72A1 and 3GTR72A1A Reverse-current Relays differ mainly in the following respects. The Model No. 3GTR72A1 is provided with a plastic cover which completely encloses the relay. The Model No. 3GTR72A1A uses instead a partially enclosing shield which does not have to be removed for mounting or adjustment. The nameplate is mounted on the base of the Model No. 3GTR72A1 and on the shield of the Model No. 3GTR72A1A. Both relays are rated at 200 amperes and 30 volts continuous.

Each relay is composed of a contactor controlled by a polarized relay. The contactor consists of a magnetic circuit and coil operating a pair of main contacts and a pair of arcing contacts. The main contacts are made of silver. The arcing contacts are copper. The copper contacts close before the silver contacts close and open after the silver contacts open, thus protecting the silver contacts

from arcing. The contactor coil is energized from the generator potential through the polarized relay contacts. The armature on which the movable contacts are mounted is balanced to minimize the effects of vibration and shock.

The polarized relay operates to connect the generator to the line at a given generator voltage, and to disconnect it from the line at a given (reverse) current flowing from the battery to the generator. If the generator voltage becomes lower than that of the bus (battery), as when the generator has been stopped, the relay will open to prevent the battery from supplying power to the generator. The polarized relay has a balanced armature which carries the movable contact. A spring, attached to the armature, exerts a torque in the proper direction to keep the relay contacts open. A potential coil in the magnetic circuit exerts a torque on the armature to close the relay contacts. When the generator voltage is below the value of pickup voltage for which the polarized relay is adjusted, the spring torque predominates and keeps the contacts open. When pickup voltage is reached, the potential coil torque overcomes the spring torque and the contacts close. Load current through the current coil will exert a torque to keep the contacts closed. Reverse current (that is, flowing from the battery to the generator) will exert a torque which opposes that of the voltage coil, and which will tend to open the contacts. A rectifier is connected in series with the potential coil to prevent pickup on reverse generator polarity.

INSTALLATION AND OPERATION

The relay should be unpacked and inspected for possible damage in shipment. Outline and mounting dimensions of the relay are shown in Fig. 4 or 5. Three holes in the plastic base are provided for mounting the relay.

After mounting, external connections should be made as shown in Fig. 6. Particular attention should be given to insure that the polarities are as indicated.

After all connections have been completed and checked, the generator may be started. The relay will close when the generator voltage is between 26 and 27 volts, connecting the generator to the line. When the generator voltage becomes lower than that of the bus (battery), a reverse current will flow causing the polarized relay to open its contacts and disconnect the generator from the line. The relay is designed so that it will open at 10 amperes (or less) of reverse current in order to prevent the battery from supplying power to the generator.

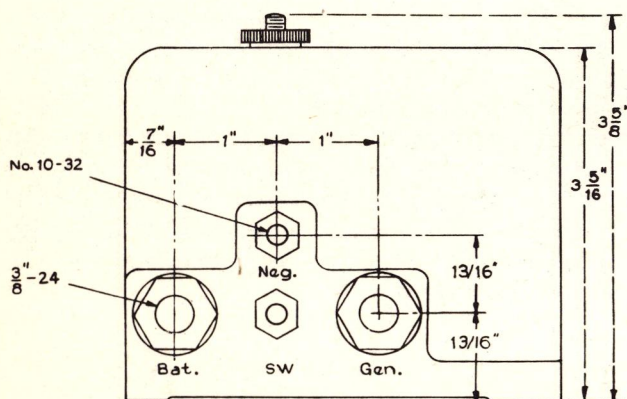
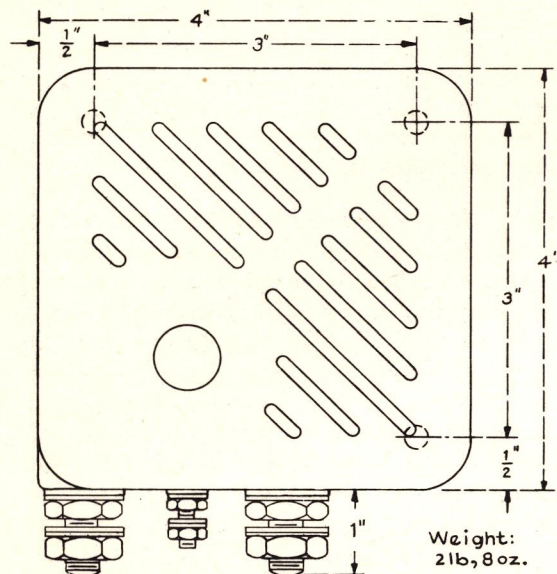


Fig. 4. Outline dimensions of relay, Model No. 3GTR72A1

INSPECTION, MAINTENANCE, AND TEST

Handle the relay carefully at all times. No oil or grease should be used on the pivots of this relay. The relay should be inspected at intervals of 240 and 1020 hours of operation as outlined below.

240 hours: Inspect the condition of the contacts and check the calibration of the contactor and the polarized relay as described in Electrical Test. If the contacts need replacing, remove the relay from service and overhaul, making the mechanical and electrical tests described in this section. Otherwise, clean the contacts with emery polishing paper (grade 1/0 or 2/0) or crocus cloth. Wipe with a clean, dry cloth and reapply contact grease, G-E Spec. D50A46.

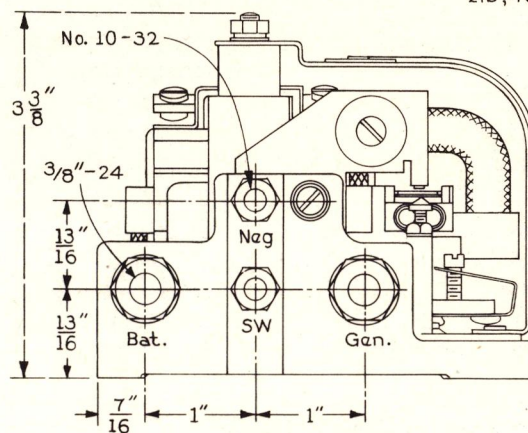
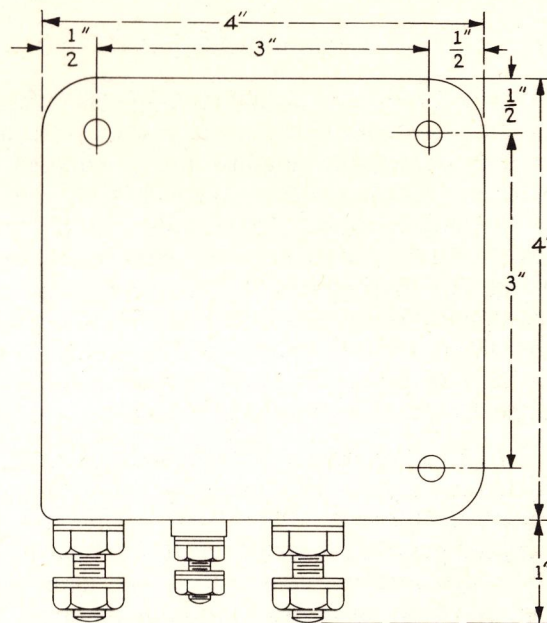


Fig. 5. Outline dimensions of relay, Model No. 3GTR72A1A

Blow out any dust or other foreign particles from the relay and recalibrate as per Electrical Test below.

1020 hours: Remove the relay from service and overhaul, making the mechanical and electrical tests described in the following paragraphs. Inspect the relay thoroughly and replace any worn, burned, or otherwise damaged parts. Check the resistance of the coils and the resistors. Readjust and retest the relay after reassembly.

If the relay should fail to function correctly, it should be tested as outlined in the following paragraphs. Reference numbers, in parentheses, refer to Fig. 7 and the Parts List,

1. Check the resistance of the coils and the re-

sistor of the rectifier and resistor assembly (52). Replace coils or resistor if the resistance is not within plus or minus five per cent of the values listed in the following table:

Description	Resistance in Ohms
Contactor Coil	76
Polarized Relay: Potential Coil	45
Resistor	250

2. On the contactor, check the sequence of the contacts. The arcing contacts (21) should close first, leaving a slight gap under the main contacts (19) at this time. As the armature (12) is pulled in further, the main contacts should close, leaving a space (about 1/32 in. minimum) under the front end of the armature, enough travel to apply pressure on the contacts. If necessary, adjustment can be made by raising or lowering the contacts until this sequence is obtained. Contact pieces are to be soldered fast after adjustment. (See REASSEMBLY for gap dimensions.) The armature should move freely and seal-in flat on the pole piece. Inspect the contactor generally for any mechanical defects.

3. On the polarized relay: Check the armature (37), which should move freely and be properly aligned with the contacts and the pole pieces. The fixed contact should be adjusted so that there is about 1/64 in. wipe to insure good contact. (See REASSEMBLY for dimensions of gaps in polarized relay.)

Electrical Test: Connect the relay according to the connection diagram, Fig. 6, adding meters and controls indicated by the dotted lines in Fig. 6. Make the electrical tests described in the following paragraphs.

TEST EQUIPMENT

Meter or Control	Designation (See Fig. 6)
Voltmeter (0-30 volts, d-c)	V1
Ammeter (0-100 amperes, d-c)	A1
Millivoltmeter (0-200 millivolts, d-c)	MV
Ammeter (0-25 amperes, d-c)	A2
Shunt (used in conjunction with A1 and A2)	S1
Switch (double-pole, double-throw; spring return to A1)	DPDT

1. With the battery and load disconnected from the line, start the generator. Close the polarized relay contacts by pushing down on the armature and increase the generator voltage until the contactor picks up. This pickup voltage (V1) should be between 17 and 21 volts. Readjustment, if necessary, (for 20 volts) may be made by means of the spring-

adjusting screw (30) on the top of the contactor, next to the cover-supporting screw. Attach the cotter pin (31) to hold the adjusting screw in place after adjustment. If the spring-adjusting screw would have to be turned down more than 1/8 in. to obtain this adjustment, increase the travel of the armature by bending up the armature stop (26).

2. Open the contactor. Reduce the voltage. Close the polarized relay contacts by hand and tap the armature (12) of the contactor so that it will pick up. The armature should seal-in flat on the pole piece when the voltage (V1) is between 18 and 19 volts. Adjust the contact pressure by means of the nut (25) on the top of the spring stud so that the armature will not seal-in flat on the pole piece at less than 18 volts, but will do so under 19 volts.

3. Apply a thin, uniform film of G-E Spec. D50A46 contact grease on the contactor contacts. Operate the contactor several times before taking any readings. Pick up the contactor and apply some convenient load (e.g. 50 amperes). This current is measured with shunt (S1) and ammeter (A1). Measure the millivolt drop across the main current studs, by touching the leads of millivoltmeter (MV) to terminals BAT and GEN. This drop should not be over the equivalent of 25 millivolts for 50 amperes. If the millivolt drop should be excessive, determine whether it is due to contact or lead resistance. If the former, polish the contacts with emery polishing paper grade 1/0 or 2/0 or crocus cloth, clean with a dry cloth, and reapply grease; or, if necessary, increase the contact pressure by tightening the nut on top of the spring stud (if permitted by the adjustment of the previous paragraph). If due to lead resistance, replace the defective shunt. The contact-pressure nut (25) should be soldered to the stud after the relay is tested.

4. Connect the battery to the bus and check the pickup voltage (V1) on the polarized relay, which should be set at 26.6 volts. Adjust the spring (65) until the voltage is correct.

5. Decrease the speed of the generator until (reverse) current (A2) begins to flow from the battery to the generator. Increase this current slowly until the relay opens and note the current, which should be below 10 amperes. If necessary, adjustment can be made by changing the wipe on the contacts. This current is measured by pushing the DPDT switch to the right. The double-pole double-throw switch should have spring return so that normally A1 is connected to the shunt.

6. If necessary, the rectifier (52) may be checked as follows: The maximum allowable current in the reverse direction through the rectifier should be approximately 50 milliamperes at 28.5 volts across the GEN and NEG terminals. Minimum current in the forward direction should be about 80 milliamperes at 28.5 volts.

DISASSEMBLY

Whenever the relay is to be disassembled, the procedure outlined in the next paragraphs should be followed. The reference numbers, in parentheses, refer to reference arrows in Fig. 7, and also the Parts List.

1. On the relay Model No. 3GTR72A1, remove the cover (70). Remove nuts (68, 54), washers (55, 72), and lock washers (56, 69). Loosen screws (67) and detach the nameplate (66). On the relay Model No. 3GTR72A1A, detach the shield (71) by removing nut (73), washer (74), and lock washer (75) and loosening screws (76), washers (77), and lock washers (78).

2. Detach spring (65) and remove screw (64) and lock washer (28). Disassemble nut (25), lock washer (28), adjusting screw (63), and post (62). Remove screw (61), washer (50), and lock washer (51), and disassemble spring (57), clamp (58), with screw (59), stud (60), and lock washer (28). Remove the solder from red-tracer lead of the polarized relay potential coil and detach from the terminal on the resistor.

3. Detach the rectifier and resistor (52) from the base by removing screw (53), washer (50), and lock washer (51).

4. Loosen the coils and base (39 or 39A) from the base by removing screw (49), washer (50), and lock washer (51). Remove the coil and shunt (46) from the contact support (8) by removing screws (48), washers (10), and lock washers (11), and remove the portion of the relay now detached.

5. Remove the armature and contact (37) from the coils and base (39 or 39A) of the polarized relay, detaching stop (38), screws (47), washers (24), and lock washers (28).

6. If necessary, remove screw (40) and lock washer (41), detaching coil and shunts (46), core and magnets (42), insulations (43, 45), and damping coil (44). Further disassembly of the coils and base (39 or 39A) is not recommended.

7. Detach the contactor, as assembled, from the base by removing screws (35, 36), washers (10), and lock washers (11), removing studs (32) and contact and shunt (33) from their holes in the base, and detaching terminal of coil lead (orange tracer) from stud.

8. Remove cotter pin (31), adjusting screw (30), and spring (29). Detach the armature (12) and parts assembled to it by removing screws (27), washers (24), lock washers (28), and stop (26).

9. Detach spring (23), washer (24), and nut (25). Remove stop (22), arcing contact bar (20) with arcing contacts (21), and main contact bar (18) with main contacts (19).

10. Remove setscrew (17) and adjusting screw (16). Detach pin (14), washers (15), and dismount bearing (13) from armature and pins (12).

11. Remove screws (48), washers (10), and lock washers (11), and detach contact and shunt (33) from the contact support. Remove stud (6) and screws (9), with washers (10) and lock washers (11), and remove contact supports (7, 8) and the pole piece (5). Remove coil assembly (4) and spacer (3) from the core assembly (1 or 2).

REASSEMBLY

Whenever the relay has been disassembled, re-assembly should be made as described in the following paragraphs. Reference numbers in parentheses refer to Fig. 7 and the Parts List.

1. Place the coil assembly (4) on the core assembly (1 or 2) with spacer (3) next to the core and on the top, as indicated in Fig. 7. The leads on the coil should be toward the support end of the core and on the right (looking from the support end). Press the core all the way in.

2. Fasten the pole piece (5) to the top end of the core (which extends beyond the coil) by means of the stud (6). Do not tighten this stud. The two tapped holes in the pole piece should be on the side farther from the coil.

3. Fasten the contact supports (7, 8) on the pole piece (5) with screws (9), washers (10), and lock washers (11). Contact supports should be located with a key that fits in the slot on the pole piece. Simultaneously tighten the screws (9) and the stud (6) holding the pole piece in order to obtain proper alignment.

4. Fasten the bearing (13), pin (14), and washers (15) on the armature and pins (12). Add the adjusting screw (16) and tighten setscrew (17) so that the shoulder on the adjusting screw is flush with the armature. Apply thermoplastic cement G-E No. 2142 to the setscrew after tightening.

5. Add the main contact bar (18) to the armature (12), complete with main contacts (19); also the arcing contact bar (20) with arcing contacts (21). Fasten the stop (22) so that its tip rests on the arcing contact bar (20) at the pin. Add the spring (23), washer (24), and nut (25).

6. Fasten the armature (12) with the parts added, to the previous assembly with the stop (26), screws (27), washers (24), and lock washers (28). Tighten the screws, lining up the armature with the pole piece. Drop the spring (29) into the spring-holder on the core assembly (1 or 2) and add the adjusting screw (30). Insert the cotter pin (31) but do not fasten until after adjustment.

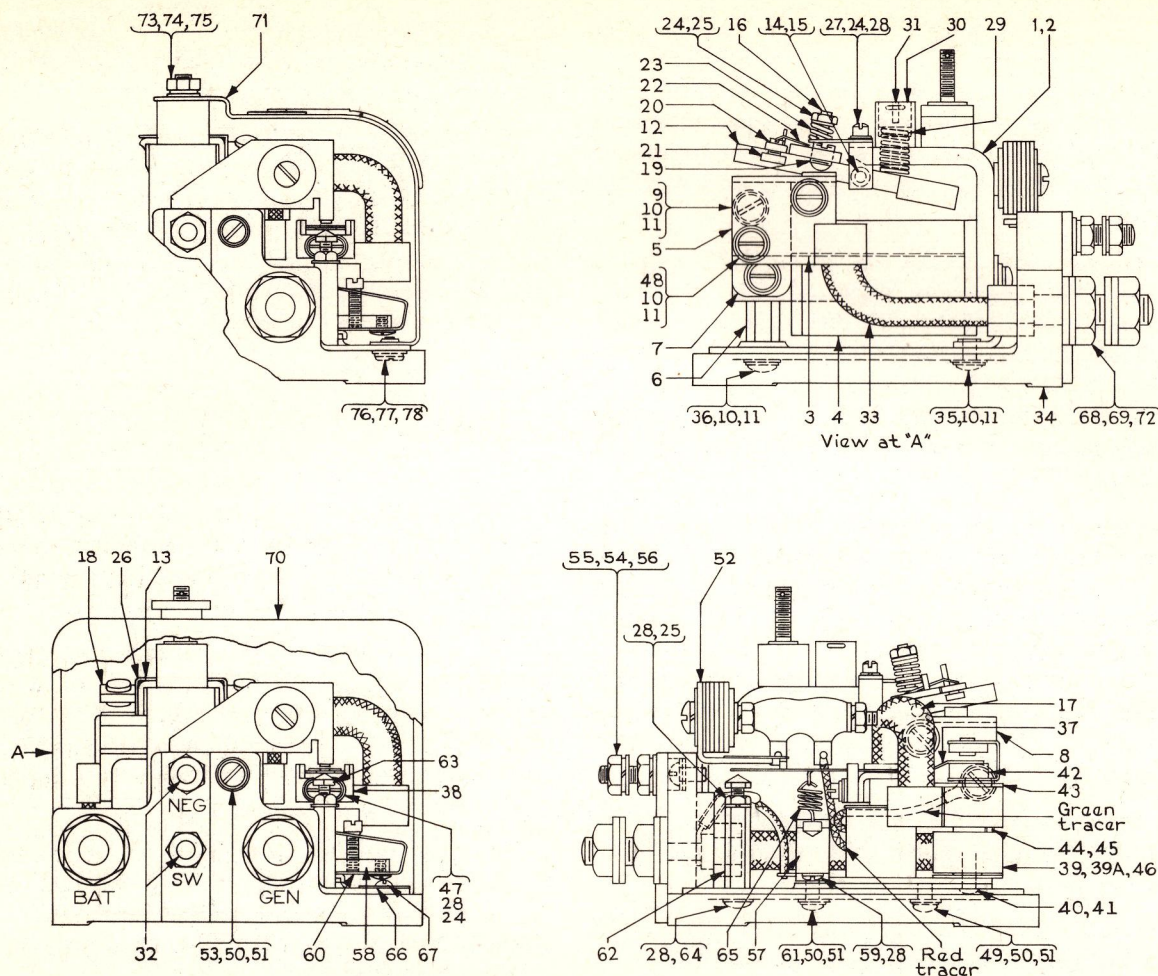


Fig. 7. Assembly of relays, Model No. 3GTR72A1 and 3GTR72A1A

7. Fasten the contact and shunt (33) to the contact support (7) with screws (48), washers (10), and lock washers (11). Insert the studs (32) and the contact and shunt (33) in their proper holes in the base. The terminal on the coil lead (orange tracer) should be inserted under the bottom stud before the stud is put in place. Mount the contactor as now assembled on the plastic base (34) with screws (35, 36), washers (10), and lock washers (11).

8. Attach the coil and shunts (46) to the polarized relay coils and base (39 or 39A) with the core and magnets (42), insulations (43, 45), and damping coil (44) in place. Fasten with screw (40) and lock washer (41). Secure screw to core with G-E No. 2142 thermoplastic cement.

9. Assemble the armature and contact (37) on the coils and base assembly (39 or 39A) with stop (38), screws (47), washers (24), and lock washers (28). Tighten the screws so that there is a gap of 0.020 inch at the potential-coil pole piece when the armature is all the way down.

10. Locate the coils and base (39 or 39A) in place on the plastic base (34) and fasten the coil and shunt (46) to the contact support (8) with screws (48), washers (10), and lock washers (11). Fasten the

terminal on the green-tracer coil lead under the lower screw. Fasten the coils and base (39 or 39A) on the base (34) with screws (49), washer (50), and lock washer (51).

11. Assemble the rectifier and resistor (52) on the base and fasten with screw (53), washer (50), and lock washer (51). Also fasten nut (54), washer (55), and lock washer (56). Solder the red-tracer lead from the polarized relay potential coil to the empty terminal on the resistor.

12. Assemble the spring (57) and clamp (58) with screw (59) and lock washer (28). Add stud (60). Mount the assembly on the coils and base (39 or 39A), by means of screw (61), washer (50), and lock washer (51), inserting the terminal on the black tracer of the contactor coil between the spring and the clamp, and the base.

13. Assemble the post (62), adjusting screw (63), nut (25), and lock washer (28), and mount the assembly on the base with screw (64) and lock washer (28). Add spring (65) in place. Fasten the nameplate (66) to the base with screws (67). Add the remaining nuts (68, 54), washers (55, 72), and lock washers (69, 56).

14. Adjust the contacts on the contactor so that

the sequence is as follows: When both arcing contacts (21) touch the contact pieces, the gap, measured at the end of the armature (12), should be 0.055 inch. When both main contacts (19) close, the gap should be 0.035 inch. Solder the contacts fast to the bar after adjustment.

15. Adjust the polarized relay as follows: The gap at the potential coil when the armature (37) is all the way down should be 0.008 to 0.010 inch. The gap at the current coil, when the armature is all the

way up should be 0.050 inch. Adjust by setting the stop at the left. The gap at the contacts when the armature is all the way down should be 0.005 to 0.008 inch.

16. The relay should now be tested as outlined under Electrical Test. After test, add cover (70) to relay Model No. 3GTR72A1. To the relay Model No. 3GTR72A1A, add the shield (71), fastening with screws (76), washers (77), and lock washers (78), and nut (73), washer (74), and lock washer (75).

RENEWAL PARTS

When ordering renewal parts, give quantity, catalog number, and description of each item required.

NOTE: Except where noted, the parts listed below are used on both relay Model No. 3GTR72A1 and relay Model No. 3GTR72A1A.

Fig. No.	Ref. No.	Cat. No.	No. Req.	Description	†Spares
-	--	-----		Reverse-current relays, Model No. 3GTR72A1 and 3GTR72A1A	
7	1	6979795G1	1	Core assembly, for Model No. 3GTR72A1	
7	2	6979795G4	1	Core assembly, for Model No. 3GTR72A1A	
7	3	8061704	1	Spacer	
7	4	8072035G1	1	Coil assembly, contactor	2
7	5	6979754	1	Pole piece	
7	6	6979769	1	Stud	
7	7	6979757	1	Support, contact	2
7	8	6979758	1	Support, contact	2
7	9	*AN515-8-7	4	Screw	
7	10	*AN960-8	11	Washer	
7	11	*AN936A8B	11	Washer, lock	
7	12	6979798G1	1	Armature and pins, contactor	
7	13	6979764	1	Bearing	
7	14	241X20	1	Pin (0.110 in. diam x 15/16 in. B6A3B2 drill rod)	
7	15	*AN960-3	2	Washer	
7	16	6979742	1	Screw, adjusting	
7	17	241X19	1	Screw, set (6-32, 1/4 in., hollow, cup pt., steel)	
7	18	6979766	1	Bar, main contact	5
7	19	8068535	2	Contact, main	10
7	20	6979767	1	Bar, arcing contact	5
7	21	8068537P1	2	Contact, arcing	10
7	22	6979749	1	Stop	
7	23	2416637	1	Spring	2
7	24	*AN960-4	5	Washer	
7	25	*AN340-4	2	Nut	
7	26	6979751	1	Stop	
7	27	*AC500-4-4	2	Screw	
7	28	*AN936A4B	7	Washer, lock	
7	29	2416636	1	Spring	2
7	30	8068532	1	Screw, adjusting	1
7	31	*AN380-2-2	1	Pin, cotter	
7	32	6979743	2	Stud	
7	33	6979793G1	1	Contact and shunt	5
7	34	8080125	1	Base, plastic	1

† Recommended for the normal maintenance of ten operating units.

* U.S. Army and Navy or Air Corps standards number.

Fig. No.	Ref. No.	Cat. No.	No. Req.	Description	†Spares
7	35	241X22	2	Screw (8-32, 5/16 in., flat-round h., steel, cd. pl.)	
7	36	241X23	1	Screw (8-32, 1/2 in., flat-round h., steel, cd. pl.)	
7	37	6979786G1	1	Armature and contact, polarized relay	2
7	38	6979772	1	Stop	
7	39	6979796G1	1	Coils and base, polarized relay, for Model No. 3GTR72A1	2
7	39A	8076157G1	1	Coils and base, polarized relay, for Model No. 3GTR72A1A	2
7	40	246X62	1	Screw (6-32, 3/8 in., flat-round h., steel, cd. pl.)	
7	41	*AN935-6	1	Washer, lock	
7	42	8079719G1	1	Core and magnets	
7	43	6966815P2	1	Insulation	
7	44	8061718	1	Coil, damping	
7	45	6979796P9	1	Insulation (25/64 in. I.D. x 27/64 in. O.D. x 31/32 in., No. 130 mica tube)	
7	46	6979797G1	1	Coil and shunt	3
7	47	*AC500-4-5	2	Screw	
7	48	*AC500-8-6	4	Screw	
7	49	241X21	1	Screw (6-32, 5/16 in., flat-round head, steel, cd. pl.)	
7	50	*AN960-6	3	Washer	
7	51	*AN936A6B	3	Washer, lock	
7	52	8061703G1	1	Rectifier and resistor	2
7	53	*AN515-6-5	1	Screw	
7	54	*AN345B10	4	Nut	
7	55	*AN960-10	4	Washer	
7	56	*AN936A10B	4	Washer, lock	
7	57	8072036	1	Spring	2
7	58	8072039	1	Clamp	2
7	59	*AN515-4-3	1	Screw	
7	60	8072040	1	Stud	2
7	61	246X59	1	Screw (6-32, 1/2 in. flat-round h., brass, cd. pl.)	
7	62	8072037	1	Post	
7	63	8072038	1	Screw, adjusting	
7	64	241X28	1	Screw (4-40, 3/8 in. flat-round h., steel, cd. pl.)	
7	65	2416638	1	Spring	2
7	66	-----	1	Nameplate (NP-93040), for Model No. 3GTR72A1	
7	67	54X270	2	Screw (No. 4, 3/16 in. Parker self-tapping, steel, cd. pl.), for Model No. 3GTR72A1	
7	68	241X26	4	Nut, check (3/8 in.-24, hex. brass, cd. pl.)	
7	69	*AN936A616B	4	Washer, lock	
7	70	8061706G1	1	Cover, for Model No. 3GTR72A1	1
7	71	8080190G1	1	Shield, for Model No. 3GTR72A1A	1
7	72	*AN960-616	4	Washer	
7	73	*AN340-8	1	Nut, for Model No. 3GTR72A1A	
7	74	*AN960-8	1	Washer, for Model No. 3GTR72A1A	
7	75	*AN935-8	1	Washer, lock, for Model No. 3GTR72A1A	
7	76	241X21	2	Screw (6-32, 5/16 in. flat-round h., cd. pl.) for Model No. 3GTR72A1A	
7	77	*AN960-6	2	Washer, for Model No. 3GTR72A1A	
7	78	*AN935-6	2	Washer, lock, for Model No. 3GTR72A1A	

* U.S. Army and Navy or Air Corps standards number

† Recommended for the normal maintenance of ten operating units

NOTE: For the normal maintenance of 10,000 operating units, it is recommended that one pound of contact grease G-E Spec. D50A46 be stocked. This contact grease is composed of 50 per cent lanolin and 50 per cent white petrolatum.

For the normal maintenance of 1000 operating units, it is recommended that one pint of thermoplastic cement G-E No. 2142 be stocked.

